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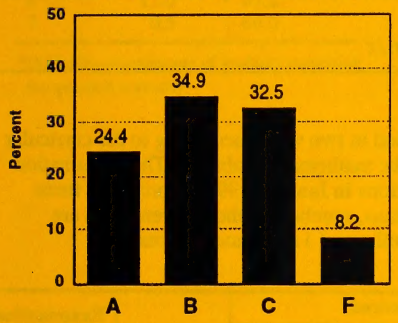
Mathematics 30

Diploma Examination Results
Examiners' Report for January 1994

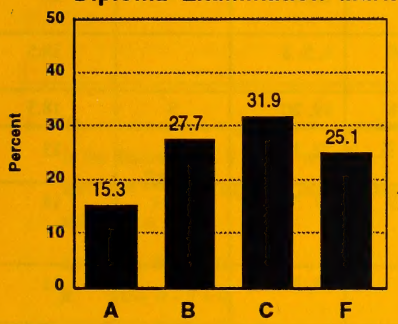
CANADIANA

AUG 9 1995

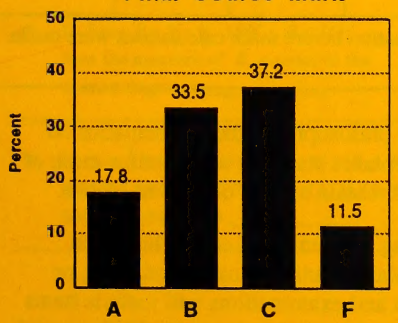
School-Awarded Mark



Diploma Examination Mark



Final Course Mark



The summary information in this report provides teachers, school administrators, students, and the general public with an overview of results from the January 1994 administration of the Mathematics 30 Diploma Examination. This information is most helpful when used with the detailed school and jurisdiction reports that have been mailed to schools and school jurisdiction offices. An annual provincial report containing a detailed analysis of the combined January, June, and August results is published each year.

Description of the Examination

The Mathematics 30 Diploma Examination consists of three parts: a multiple-choice section of 42 questions worth 60%, a numerical-response section of seven questions worth 10%, and a written-response section of four questions worth 30% of the total examination mark.

Achievement of Standards

The information reported is based on the final course marks achieved by 10 585 students who wrote the January 1994 examination.

- 88.5% of these students achieved the acceptable standard (a final course mark of 50% or higher).
- 17.8% of these students achieved the standard of excellence (a final course mark of 80% or higher).

Approximately 50% of the students who wrote the January 1994 examination were females.

- 88.5% of these students achieved the acceptable standard (a final course mark of 50% or higher).
- 16.7% of these students achieved the standard of excellence (a final course mark of 80% or higher).

Approximately 50% of the students who wrote the January 1994 examination were males.

- 88.4% of these students achieved the acceptable standard (a final course mark of 50% or higher).
- 18.8% of these students achieved the standard of excellence (a final course mark of 80% or higher).

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Student Evaluation

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Provincial Averages

- The average school-awarded mark was 68.1%.
- The average diploma examination mark was 61.3%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 65.1%.

2009 students who wrote the January 1994 examination had written at least one Math 30 exam previously. Their performance on the January 94 examination increased to a mean of 61.9% from a mean of 48.7% on previous examinations.

Results and Examiners' Comments

Subtest

When analyzing detailed examination results, please bear in mind that subtest results **cannot** be directly compared.

Results are in average raw scores.

Machine scored: 30.6 out of 48

Written response: 11.6 out of 21

Course Content

- Polynomial Functions: 4.9 out of 9
- Trigonometric and Circular Functions: 8.0 out of 13
- Statistics: 8.2 out of 13
- Quadratic Relations: 4.5 out of 8
- Exponential and Logarithmic Functions: 5.6 out of 9
- Permutations and Combinations: 5.2 out of 8
- Sequences and Series: 5.9 out of 9

Mathematical Ability *

- Procedural: 11.4 out of 17
- Conceptual: 9.6 out of 15
- Problem Solving: 9.6 out of 16

*Refer to Appendix D of the 1993–94 *Mathematics 30 Information Bulletin, Diploma Examinations Program* for an explanation of mathematical abilities.

Note: The written-response section spans all mathematical abilities.

Examination Blueprint

Each question on the examination is classified in two ways: according to the curricular content area being tested and according to the mathematical ability. The examination blueprint illustrates the distribution of questions in January 1994 according to these classifications. In the machine-scored columns, numbers without parentheses are multiple-choice questions and those in parentheses ( ) are numerical-response questions.

Course Content	Machine Scored			Written Response	Examination Emphasis (%)
	Procedural	Conceptual	Problem Solving		
Polynomial Functions	(1)	12	13, 14	1	13
Trigonometric and Circular Functions	2, 3, 6, 11 (2), (3)	1, 7, 9, 10	4, 5, 8		18.5
Statistics	15	16, 17, 18	19, 20	3	18.5
Quadratic Relations	(4)	21	22, 23†	4	13
Exponential and Logarithmic Functions	24, 25, 30	26, 28, 29	27, 31, (6)		13
Permutations and Combinations	35, 36, 38	32, 37	33, 34, (5)		11
Sequences and Series	40, 41	39	42, (7)	2	13
Examination Emphasis (%)	24.3	21.4	24.3	30	100

†Question 23 was dropped from the examination before mark calculations were made.

This examination has a balance of question types and difficulties reflecting the philosophy of the Mathematics 30 Course of Studies. It is designed so that students capable of achieving the acceptable standard will obtain a mark of 50% or higher and students capable of achieving the standard of excellence will obtain a mark of 80% or higher.

Future examinations will continue to focus on assessing students' understanding mathematical concepts and on problem solving. Students will continue to be expected to solve problems, explain solutions, justify solutions, or prove solutions in the written-response section. The design of future field tests and examinations will include items that assess how well students have achieved the general learner expectations stated in the Mathematics 30 Course of Studies.

Machine Scored

Numerical Response

Question	Answer	Difficulty*
1	10.5	68.6
2	262	41.6
3	19.5	51.2
4	2.0	60.8
5	240	38.1
6	17.0	67.2
7	0.5	66.0

*Difficulty—percentage of students answering the question correctly

Multiple Choice

Question	Key	Difficulty*	Question	Key	Difficulty	Question	Key	Difficulty
1	B	82.7	15	B	88.3	29	D	36.6
2	D	64.3	16	B	66.9	30	A	39.6
3	D	53.4	17	C	89.3	31	D	67.7
4	C	47.0	18	D	34.7	32	C	77.4
5	C	68.3	19	C	79.4	33	B	70.1
6	D	67.6	20	C	50.4	34	D	63.3
7	A	72.8	21	A	68.5	35	B	78.2
8	C	65.7	22	A	63.2	36	A	44.1
9	B	74.7	23 †			37	A	63.7
10	C	57.4	24	D	90.9	38	C	82.2
11	A	50.8	25	C	86.7	39	B	66.9
12	B	61.9	26	A	69.5	40	C	89.1
13	B	52.3	27	B	68.3	41	A	82.7
14	D	34.8	28	D	36.0	42	B	61.4

*Difficulty—percentage of students answering the question correctly

†This question was not included in the final analysis of the examination because the wording led to three of the four alternatives.

The machine-scored section of the examination asks a sample of questions that cover all content areas in Mathematics 30. A discussion about how well students meet the curriculum standards in the units trigonometric and circular functions and exponential and logarithmic functions follows.

Trigonometric and Circular Functions—Students who meet the acceptable standard in this unit are expected to be able to solve a first-degree primary trigonometric equation. Multiple-choice question 6 and numerical-response questions 2 and 3 asked students to solve trigonometric equations. Multiple-choice question 6 asked students to identify an equation, given its solution. Of all students who met the acceptable standard on the examination, 72.9% were able to do this. Numerical-response question 2 asked students to solve a first-degree primary trigonometric equation within a specified domain. Only 45.5% of all students who met the acceptable standard on the examination were able to do this. Finally, numerical-response question 3 asked students to solve a second-degree trigonometric equation. It is expected that students who met the standard of excellence can do this, in fact, 90.3% of the students who met the standard of excellence on the examination can. Of the students who met the acceptable standard but not the standard of excellence, 48.3% were able to do this question.

Students are also expected to describe the relationship between the root(s) of a trigonometric equation and the graph of its corresponding function. Multiple-choice questions 1, 4, 5, 8, 9, and 10 asked students about the skills required to describe this relationship. Multiple-choice question 10 actually provided the graph of a trigonometric function and asked students to identify the number of solutions to the equation within a specific domain. Only 54.1% of the students who met the acceptable standard but not the standard of excellence on the examination were able to do this.

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6. The solutions to a trigonometric equation in the domain $0 \leq \theta < 2\pi$, are $\theta = \frac{\pi}{3}$ and $\theta = \frac{5\pi}{3}$. An equation that has these solutions is

A. $3 \sin \theta - 1 = 0$

B. $3 \cos \theta - 5 = 0$

C. $2 \sin \theta - 1 = 0$

•**D.** $2 \cos \theta - 1 = 0$

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2. If $7 \cos \theta + 1 = 0$, $180° < \theta < 360°$, then the measure of θ, correct to the nearest degree, is _____.

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3. If $3\sin^2 \theta + 5 \sin \theta - 2 = 0$, $0° \leq \theta \leq 90°$, then the measure of θ, correct to the nearest tenth of a degree, is _____.

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27. The half-life of a tracer element in the human body is 100 minutes. At noon, the mass of the tracer element is 0.700 g. Correct to the nearest thousandth of a gram, the expected mass of the same tracer element in 320 minutes is

A. 0.093 g
•B. 0.076 g
C. 0.066 g
D. 0.044 g

28. In solving the equation $\log_6(x-5) + \log_6(x-6) = 1$, a student correctly arrives at a step where $x = 8$ or $x = 3$. When these two values of x are verified,

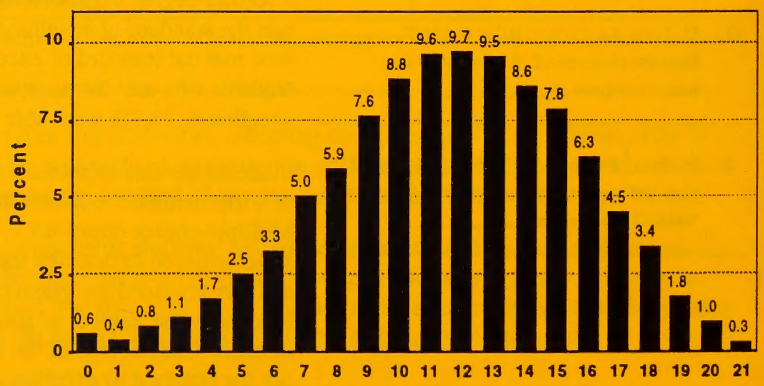
A. neither $x = 8$ nor $x = 3$ satisfies the equation
B. both $x = 8$ and $x = 3$ satisfy the equation
C. only $x = 3$ satisfies the equation
•D. only $x = 8$ satisfies the equation

In addition, students should be able to demonstrate, by simplifying and evaluating trigonometric expressions, an understanding that trigonometric identities are equations that express relations among trigonometric functions that are valid for all values of the variables for which the functions are defined. Multiple-choice questions 2, 3, 7, and 11 dealt with this curriculum standard. About 55% to 66% of the students who met the acceptable standard on the examination were able to correctly answer questions 2, 3, and 11, whereas about 78% of the students were able to correctly answer question 7.

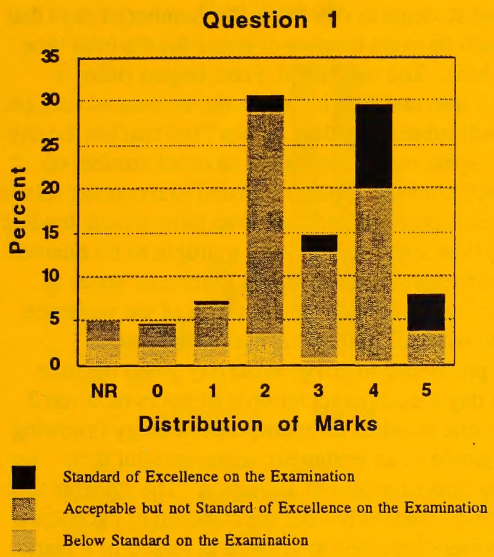
Exponential and Logarithmic Functions—In order to meet the curriculum standards for this unit, students should describe orally and in writing that the inverse of the exponential function is the logarithmic function and then use this information in the solution of exponential equations. Students should also solve exponential equations, recognize the graphs of exponential and logarithmic functions, and express an exponential expression in logarithmic form and vice versa. Multiple-choice questions 24 to 31 and numerical-response question 6 asked students to demonstrate their understanding of this unit. Between 72% and 92% of the students who met the acceptable standard on the examination were able to demonstrate this on multiple-choice questions 24, 25, 26, 27, 31 and numerical response question 6. Only about 40% of the students who met the acceptable standard on the examination were able to determine whether or not particular values were solutions to a logarithmic equation, the range of a logarithmic function, or to recognize the equivalency between two logarithmic expressions as demonstrated by multiple-choice questions 28, 29, and 30.

Written Response

Questions in the written-response section dealt with four of the seven content strands for Mathematics 30. Students performing at the acceptable standard were expected to obtain at least half marks on all questions. Students performing at the standard of excellence were expected to answer all questions almost perfectly.



Distribution of Marks for Written Response



Question 1 required students to verify algebraically that the graph shown was indeed the graph of the the given function. Students needed to be able to determine that the roots of the equation corresponded to the x-intercepts of the graph shown, then discuss the y-intercept or some other attribute of the graph and its relation to the equation. Students who are meeting the acceptable standard in Mathematics 30, when given any integral polynomial function of degree 3 or less, can determine its zeros, its factors, and its graph and can describe, in writing, the relationship among its zeros, its factors, and its graph. It was expected that students who met the acceptable standard on the examination would score 3 or 4 of 5 on this question. On this question, 44.6% of the students who met the acceptable standard received either 3 or 4 marks and 5.2% achieved 5 marks on this question. The student who met the standard of excellence on the examination should have obtained 5 of 5 on this question. Of the students who met the standard of excellence on the examination, 24.4% did achieve the full marks while 53.6% achieved 4 of 5 marks.

On this 5-mark question, the average mark was 2.86 or 57.2%.

Scoring Question 1: The scoring guide for question 1 follows.

Scoring Guide for Written-Response Question 1

5 Student indicates that the graph provided is indeed the graph of $P(x)$ by
- correctly completing an algebraic solution
- linking the graph and the algebraic solution

4 Student indicates that the graph provided is indeed the graph of $P(x)$ by correctly completing an algebraic solution and
- linking the solution to the graph but the solution is missing an element that uniquely determines the graph of the function or one element listed contains a flaw.

OR

- the graph is uniquely determined by the conditions stated but the conclusion is left to the reader.

3 Student begins an appropriate strategy and carries it through. There are some errors in the strategy or its application that prevent the student from carrying through to a correct answer.

OR

Student correctly determines the zeros of the function but does not link them to the graph.

2 Student begins a strategy but is unable to carry it through.

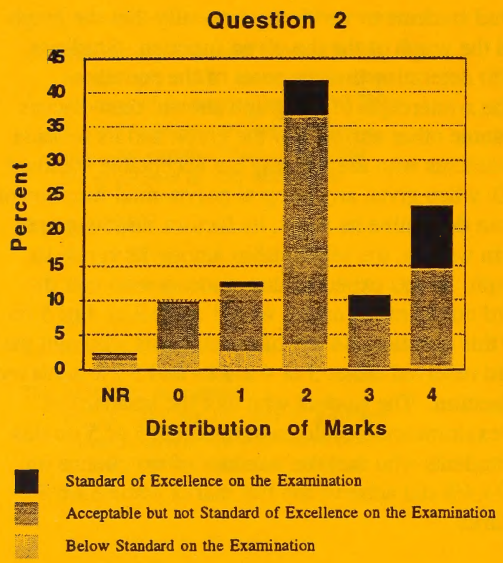
1 The student selects a strategy such as verifying the y-intercept **or** attempting to factor $P(x)$ **or** determining an x-intercept **or** links the graph and the equation defining the function.

0 The student simply recopies data from the problem but does nothing further with the data.

OR

The work done by the student shows no understanding of the problem.
The student provides an incorrect solution with no other work shown.

Note: The acceptable standard states that students are able to recognize geometric and arithmetic sequences; hence, no mark will be given for claims that the sequence is arithmetic.



Question 2 required students to determine the number of days that it would take to reach an exact number of hours for the total time riding a stationary bike. The individual, Fred, begins riding a stationary bike for 2 min and then increases the amount of time per day by 2 min on each subsequent day. When Fred reaches the day when the total time spent riding the bike is an exact number of hours, he will reward himself. Students needed to recognize this as an arithmetic sequence problem and then determine which day that the total amount of time spent riding was a multiple of 60 minutes. Some students used the sum formula for an arithmetic series to solve this and some students wrote out the terms of the sequence. Those students who recognized that this was an arithmetic sequence and then proceeded to arrive at the day when the time spent riding on the day was an exact number of hours received 2 marks. They were able to select an appropriate strategy (knowing that this was an example of an arithmetic sequence) but then implemented the incorrect process to a solution. The students who met the the acceptable standard but not the standard of excellence on the examination were expected to achieve at least 2 of 4 marks on this question. Of these students, 76% received either 2, 3, or 4 marks on this question. Students who met the standard of excellence on the examination were expected to achieve 3 or 4 marks on this question. Of the students who met the standard of excellence, 67.6% met this expectation.

On this 4-mark question, the average mark was 2.21 or 55.3%.

Scoring Question 2: The scoring guide for question 2 follows.

Scoring Guide for Written-Response Question 2

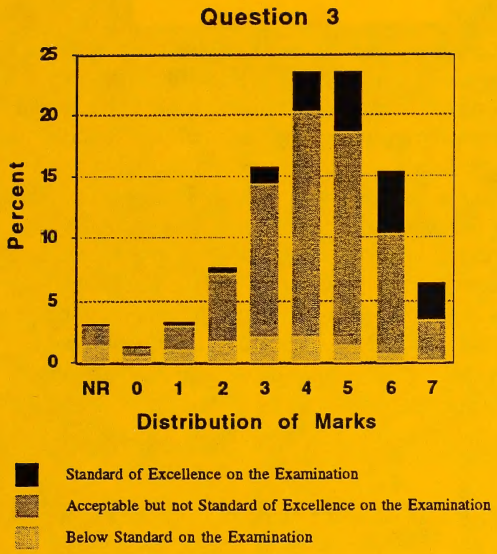
4 These papers have the following characteristic:
- Appropriate strategies were selected and implemented. The correct answer was given in terms of the data of the problem.

3 These papers have one of the following characteristics:
- Appropriate solution strategies were properly applied, but —
  a) the student answered the problem incorrectly
  OR
  b) the correct numerical part of the answer was given and the answer was not labelled or was labelled incorrectly
  OR
  c) the student appears to have made an error copying information from the problem or in computation
- The correct answer is given, and there is some evidence that appropriate solution strategies were selected.

2 These papers have the following characteristics:
- An appropriate strategy was used, but —
  a) it was not carried out far enough to reach a solution
  OR
  b) it was implemented incorrectly and thus led to no answer or an incorrect answer

1 These papers have one of the following characteristics:
- There is a start toward finding the solution that reflects some understanding and is beyond just copying data, but the approach used would not have led to a correct solution.
- The correct answer is shown, but —
  a) the work is not understandable
  b) no work is shown

0 These papers have one of the following characteristics:
- The data in the problem may be simply recorded, but nothing is done with the data or there is work but no apparent understanding of the problem.
- There is an incorrect answer and no other work is shown.



Question 3 required students to design a survey that would be appropriate for a school board to use to find out how people in the communties it serves feel about a proposal to change the school year. Students needed to define a population that could be sampled, identify and explain how a sample would be chosen from this population, provide the wording for an appropriate question that would give the school board relevant data, and explain why the format of the question would give the school board the information they required. Students who meet the acceptable standard in Mathematics 30 are expected to be able to design and administer surveys, collect and organize results, and draw inferences from surveys, as well as assess the strengths, weaknesses, and biases of samples. Students who met the acceptable standard on the examination were expected to score at least 5 of the 7 marks on this question. About half of the students who wrote the examination met or exceeded this expectation. Students who met the standard of excellence on the examination were expected to score 6 or 7 marks on this question. About 44% met this expectation.

On this 7-mark question, the average mark was 4.15 or 59.2%.

Scoring Question 3: The scoring guide for question 3 follows.

Scoring Guide for Written-Response Question 3

Population

2 Population is well-defined and exists within the "communities" of the school board.
- well-defined means that any individual can be clearly identified as belonging or not belonging to the population

1 Population is identified
- bat is not well-defined although it appears to exist within the "communities" of the school board. OR
- and well-defined but does not exist within the "communities" of the school board.

0 No population is specified OR
The population identified is neither well-defined nor does it exist within the "communities" of the school board.

Sample

2 Student describes a valid sampling technique that will likely result in a representative sample of the indicated population.

1 Student describes a sampling technique that is not likely to result in a representative sample of the indicated population. OR
The sample identified is representative of the population that is identified or implied but sampling technique is not explained at all or contains a flaw.

0 No sample is specified.

Question

1 The question as stated deals with the issue specified in the problem statement.

0 The question asked does not deal with the issue specified in the problem statement. OR
There is no question stated

Explanation of the Format of the Question

2 The student clearly links the **format** of the question with a valid reason for believing the data provided by the survey will give the school board the information they require.

1 The student
- identifies the data that the question will likely generate without explicitly linking it to the format of the question OR
- identifies the format of the question but is not able to link the format to a valid reason for believing that the data will provide the school board with the information they require.

0 No discussion **or** the student restates the wording in the assignment **or** the student has an invalid explanation.

Notes:
- The question does not need to be a YES/NO question.

Possible explanations for the format include (but are not restricted to):
- YES/NO format of the question forces a choice on the respondents resulting in a clear determination of opinion of those sampled.
- YES/NO response leads to a sample proportion from which the population percentage can be determined to a level of accuracy determined by the size of the sample.
- Clear and simple wording ensures that the question is understood.

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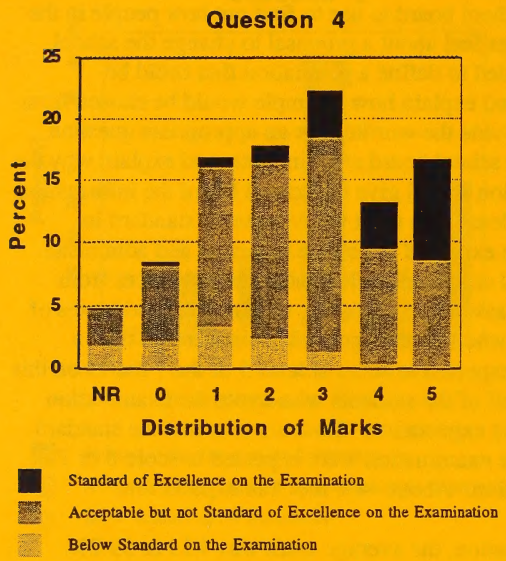

Question 4, part a, required students to determine the graph of a quadratic relation given a point on the graph and the two foci. Parts b and c then asked students to describe how the curve would change if the foci were moved closer together and then describe the effect on the value of the quadratic relations' eccentricity of moving the foci together. Sudents who met the acceptable standard on the examination were expected to be able to recognize that the quadratic relation was an ellipse and then draw its graph. About half of the students who met the acceptable standard but not the standard of excellence on the examination met or exceeded this expectation. Students who met the standard of excellence on the examination were expected to not only plot the quadratic relation but to also correctly answer parts b and c. Of the students who met the standard of excellence on the examination, 65.8% met this expectation.

On this 5-mark question, the average mark was 2.55 or 51.1%.

Scoring Question 4: *Part a* was worth 3 marks, *Part b* was worth 1 mark, and *Part c* was worth 1 mark. The scoring guide for question 4 follows..

Scoring Guide for Written-Response Question 4

Part a

3 Student identifies three points on the ellipse and has a reasonably accurate drawing of the ellipse.
OR
Student correctly draws the ellipse.

2 Student correctly identifies three points, in addition to Point P, on the quadratic relation.
OR
Student indicates and uses a sum of the focal radii to choose points on an ellipse and then attempts to draw an ellipse using symmetry to determine the other vertex of the ellipse.

1 Student indicates in some way that the quadratic relation is an ellipse. The information used to indicate this is correct.
OR
Student plots at least one other point, in addition to Point P, on the quadratic relation accurately.

Part b

1 Student in some way indicates that the graph of the quadratic relation becomes circular.

Part c

1 Student in some way indicates that the value of the eccentricity of the quadratic relation approaches zero.

For further information, contact Florence Glanfield or Phill Campbell at the Student Evaluation Branch, 427-0010.